introduced among the Decapoda by the Rhizocephalan Cirripedes. While one branch of the Cryptoniscidæ has remained faithful to its first hosts, another has become adapted to direct parasitism upon the Decapods, and has given origin to the group of *Phryxus*, *Bopyrus*, and the Entoniscidæ.

Thus, by a fact of ethological atavism, would be explained the simultaneous presence, so often ascertained, in the same Decapod, of a Rhizocephalan and a Bopyrian parasite (*Sacculina Carcini* and *Portunion Mœnadis*, *Entoniscus Porcellanæ* and *Lernæodiscus Porcellanæ*, &c.).

The existence of a Phryxoid stage in the evolution of the females of most Bopyrinæ shows that the genus *Phryxus* may be regarded as the stock from which there have issued, on the one hand, the Ioninæ, which are in a manner an exaggeration of it; and, on the other, the asymmetrical branchial Bopyrinæ. This Phryxoid stage is observed in *Pleurocrypta*, *Bopyrus*, *Cepon*, *Ione*, &c. It has caused many errors on the part of the zoologists who first studied these animals. The *Phryxus*-stage of *Cepon typus* was taken by Duvernoy for the male of that Bopyrian. *Phryxus fusticaudatus*, Sp. B. & W., is the *Phryxus*-stage of *Pleurocrypta Hyndmanni*, Sp. B. & W.*; *Phryxus longibranchiatus*, Sp. B. & W., corresponds in part to the *Phryxus*-stage of *Pleurocrypta Galatheæ*, Hesse (*non* Sp. B. & W.†). In the Entoniscidæ the *Phryxus*-stage appears less distinctly, and it is possible that this group may have diverged from the stock at a very ancient period, which would be in accordance with its more decided parasitism.—*Comptes Rendus*, May 9, 1887, p. 1309.

On Parasitic Castration in Eupagurus Bernhardus, *Linné*, *and in* Gebia stellata, *Montagu*. By M. A. Giard.

In a recent memoir‡ I made known the curious morphological effects produced in several Decapod Crustacea by the castration produced by the presence of Rhizocephalan or Bopyrid parasites. Further and very remarkable examples of these phenomena are presented by the hermit-crabs infested by *Phryxus Paguri*, Rathke, and by the *Gebiæ* infested by *Gyge branchialis*, Corn. & Panc. Although *Phryxus Paguri* is an absolutely external parasite, the modifications which it occasions are as extensive as those observed in certain Brachyura in consequence of their infestation by Rhizocephalans.

It is well known what are the external sexual characters of the *Eupaguri*. In the female the genital aperture is situated upon the basal joint of the third pair of thoracic feet; in the male this orifice is placed upon the base of the fifth pair of feet, which bears

* We have met with this Bopyrian of the branchial cavity of *Pagurus Bernhardus* at Roscoff, and at Equihen, near Boulogne-sur-Mer.

† We have studied this parasite of *Galathea squamifera* at Roscoff and at Fécamp.

‡ Bull. Sci. du Nord, tome xviii. (1887), pp. 1–28. Translated in 'Annals,' May 1887, pp. 325–345.

a small papilla; the large chela of the first pair of thoracic feet is rather stronger in the male than in the female. As regards the abdomen, the first segment is destitute of limbs in both sexes. In the female segments 2, 3, 4, and 5 bear, on the left side, appendages formed of a basal joint terminated by two branches. On the second segment the outer branch is shorter than the inner one; on the third, the two branches are nearly of the same length; on the fourth, the outer branch is a little longer, and on the fifth segment it is much longer than the inner one. The appendages 2, 3, 4 are constructed to retain the eggs. For this purpose their basal joints bear two tufts of hairs; the inner branch also presents two tufts of hairs, one at its extremity, the other on a highly developed posterior swelling.

In the male segment 2 is destitute of appendages, segments 3, 4, and 5 bear on the left side biramose feet, of which the inner branch, which is always without a posterior enlargement, is much smaller than the outer one. The appendages of the fifth segment are very similar in the two sexes.

The male hermit-crabs infested by *Phryxus Paguri* are scarcely altered in the thoracic region, except that the large chela may be a little smaller than usual. *But the abdomen presents appendages in equal number to those of the female, and constructed absolutely as in the female, although of rather smaller dimensions.*

On opening one of these males with female abdominal feet we find the testis containing spermatophores of much less than the normal size (about one half), and very imperfect spermatozoids.

I expected to meet with the same phenomena, perhaps even more accentuated, in male hermit-crabs infested by *Peltogaster Paguri*; but, astonishing to say, there is nothing of the kind; and notwithstanding the more profound action which we should be inclined, *à priori*, to ascribe to the *Peltogaster*, that Rhizocephalan produces no apparent modification of the external characters of the male sex, although it causes the sterility of its host.

The female hermit-crabs infested by *Peltogaster*, on the other hand, are frequently modified, and the modifications of course affect the abdominal feet. The tufts of hairs on the basal joint and the posterior ovigerous projection of the branch disappear more or less completely; further, the inner branch is generally smaller than the outer one, even in the appendages 2 and 3; in one word, the abdominal feet of these castrated females clearly approach those of the male sex.

From what precedes we are led to conclude either that certain *Peltogasters* attach themselves to the hermit-crabs at a later period than the *Phryxi* or that the *Peltogasters* exert a slower action than the *Phryxi*, and do not prevent the sexual differentiation from being produced, at least in the male sex. The former interpretation, in our opinion, is the more probable.

Further, the facts just noted seem to indicate that the *Phryxi* in general attach themselves to the hermit-crabs at an age when the sexual differentiation has not been effected, and while the Decapod crustacean still presents the embryonic abdominal feet. Now Fritz

Müller has made known a *Phryxus* of the Brazilian coast (*Phryxus resupinatus*) which constantly attaches itself to hermit-crabs infested by *Peltogaster purpureus*, and often upon the very peduncle of that Rhizocephalan. If we accept the hypothesis of the inoculation of the larvæ of Rhizocephala put forward by M. Y. Delage, it would therefore be necessary to suppose that the larva of *Phryxus resupinatus* divines which are the hermit-crabs inoculated with an embryo *Peltogaster*, and the precise place at which this embryo will emerge from the abdomen of the hermit-crab. We can escape from this curious conclusion only by assuming, upon a still more curious hypothesis, that the embryos of *Phryxus* themselves are also inoculated and follow the larvæ of *Peltogaster* in their internal migration. Who would accept such a complication? On the other hand, all becomes simple on the theory of direct fixation, and we may find in the new facts above described a confirmation of the opinion expressed by us, that in the phylogenetic series the Cirripedes have been the introducers of the Bopyridæ among the Decapod crustaceans. The Isopods, originally parasitic upon the Rhizocephala, have infested the higher crustacean, at first indirectly, but afterwards directly.

I have endeavoured to extend the observations relating to parasitic castration to other Decapods, but unfortunately the materials for such an investigation are difficult to get together. Notwithstanding my great desire to do so, I have as yet been unable to examine male *Callianassæ* infested either by *Parthenopea subterranea* or by *Ione thoracica*. Although *Gebia stellata*, Montagu, is abundant at various parts of the coast of France (especially at Concarneau), I have never found on our shores the parasitic Bopyrid of that species, *Gyge branchialis*, Cornalia and Panceri. I possess a single example of an infested *Gebia*, which came from the Laboratory at Naples. This specimen, however, is a male, and I have been able to ascertain that it presents the first pair of simple abdominal feet which normally exists only in the female; the chela of the first pair of thoracic feet has remained stronger than in the females. Nardo, who observed in a locality where *Gyge branchialis* is abundant, says that he has sometimes found the first abdominal appendage in both sexes:—"Io posso assicurare però che di tali appendici poste una per lato sotto il primo anello dell' Addome, va pure fornita la femmina, *ed essere anche vero che talvolta ne sono entrambi sprovvedati*" *. It is probable that these abnormal males were or had been infested by *Gyge*.

The Brachyura infested by the Bopyridæ of the genus *Cepon* (*Pilumnus hirtellus* and *Xantho floridus*) and examples of *Porcellana longicornis* infested by *Pleurocryptus Porcellanæ* have presented no appreciable modification of the external sexual characters.—*Comptes Rendus*, April 18, 1887, p. 1113.

* Nardo, 'Annotazioni illustranti 54 specie di Crostacei,' Venice, 1869, p. 100.